

Jurnal Sains Kesihatan Malaysia 7 (1) 2009: 49-58

Kertas Asli/Original Article

**Corneal Thickness and Curvature of One Sample of
Young Myopic Population in Malaysia**
(Ketebalan dan Kelengkungan Kornea Satu Sampel
Populasi Miop Muda di Malaysia)

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ABSTRACT

The purpose of this study is to determine the standard value of corneal thickness (CCT) and its relationship with the degree of myopia amongst one sample of myopic students in Malaysia. Eighty-four myopic subjects (168 eyes) were examined in this study. Ocular examination included subjective refraction, keratometry (Shin-Nippon, Japan) and optical pachometry (Sonogage INC). Corneal thickness was measured at five different locations i.e. central, superior, inferior, nasal and temporal of the cornea. However, only association of CCT with myopia is reported in this article. Mean age of subjects was 21.42 ± 1.47 years old (20.34 ± 1.15 ; 22.46 ± 0.88). Mean refractive error in spherical equivalent for the whole sample was -3.50 ± 2.10 DS. Mean corneal curvature for the all subjects was 7.74 ± 0.52 mm and mean value of CCT was 594.62 ± 66.51 mm. Significant differences ($p < 0.05$) were found between mean CCT of low myopes (-4.00 DS and below) and higher ones (-4.25 DS and above), but not with mean of keratometer readings. Poor correlations were obtained between refractive error and CCT ($r = 0.125$, $p > 0.05$) and between refractive error and corneal curvature ($r = 0.24$, $p > 0.05$). It was concluded from this study that high myopic subjects has significantly thinner CCT than lower ones. Measurement of CCT should be considered when undertaking procedures such as LASIK and orthokeratology.

Key words: Myopia, Corneal thickness, Corneal curvature, Keratometry

ABSTRAK

Kajian ini bertujuan untuk menentukan nilai piawai ketebalan kornea serta hubungan ketebalan kornea sentral (CCT) dengan tahap miopia di kalangan satu sampel pelajar miop di Malaysia. Seramai 84 orang subjek (168 biji mata) dari bangsa Melayu dan Cina telah menyertai kajian ini. Pemeriksaan

yang dijalankan meliputi refraksi subjektif, keratometri (Shin-Nippon, Japan) dan pakometri optikal (Sonogage INC). Ketebalan kornea diukur di lima lokasi berbeza; sentral, temporal, nasal, inferior dan superior. Hanya hubungan (CCT) dengan tahap miopia yang akan dibincangkan. Purata umur keseluruhan subjek adalah 21.43 ± 1.48 tahun. Nilai miopia dalam sfera setara untuk keseluruhan subjek adalah -3.61 ± 2.10 DS. Nilai purata keratometer adalah sebanyak 7.74 ± 0.52 mm. Purata nilai CCT untuk keseluruhan subjek adalah 594.62 ± 66.51 mm. Analisis menunjukkan purata CCT adalah lebih rendah secara signifikan dari periferi kornea. Perbezaan CCT yang signifikan ($p < 0.05$) juga didapati antara subjek miop tinggi (-4.25 DS ke atas) dan rendah (-4.00 DS ke bawah) tetapi tidak untuk kelengkungan kornea. Korelasi yang lemah didapati antara tahap miopia dan CCT ($r = 0.125$, $p > 0.05$) serta kelengkungan kornea ($r = 0.24$, $p > 0.05$). Kajian ini menyimpulkan bahawa subjek miop tinggi mempunyai CCT yang lebih nipis berbanding subjek miop rendah. Pengukuran CCT perlu dipertimbangkan untuk prosedur seperti LASIK dan orthokeratologi.

Kata kunci: Miopia, Ketebalan kornea, Kelengkungan kornea, Keratometeri

INTRODUCTION

Myopia is a common cause for visual impairment among young population in Asia. Estimates of the proportion of myopia in the young population in Asia ranged from 30% to 65% (Saw et al. 1996; Chow et al. 1990), and the prevalence was found to be greater among Chinese people (Wensor et al. 1999; Sperduto et al. 1983). In Malaysia, the prevalence of myopia found among Malay, Chinese and Indian schoolchildren was 47%, 20% and 19.4% respectively (Garner et al. 1990; Chung et al. 1995; Saadah et al. 2002). With the increasing rates of myopia, orthokeratology and refractive surgery such as LASIK, has become quite popular in Asia. When undertaking such procedures to correct myopia, CCT is an important consideration in order to prevent the cornea from becoming too thin after the treatment. Standard value and range of CCT and its relationship to the degree of myopia among normal population should be available in every country.

Most reports on CCT indicate that CCT ranges from 500 to 600 μ m in the normal population with many factors affecting CCT values such as race, gender, age, refractive status, corneal curvature and intra ocular pressure (Lam and Douthwaite, 1998; Foster et al. 1998; Eysteinson et al. 2002; Hahn et al. 2003; Fam et al. 2006). Earlier works attempted to investigate the relationship between myopia with CCT and corneal curvature produced conflicting results. Chang et al. (2001) studied the effect of myopia on corneal dimension. Two hundred and sixteen subjects with mean age of 22.22 ± 4.23 years old and mean refractive error of -4.17 ± 5.03 D were involved in study. Cycloplegic refraction, corneal curvature and CCT measurement was conducted on all subjects. Analysis of their results

showed significantly thinner CCT in myopic eyes. However, no correlation was found between CCT and corneal curvature ($r = -0.13$, $p = 0.093$).

In a more recent study, Fam et al. (2006) measured CCT and its relationship with myopia among Chinese adults (age range: 15 to 59 years old) attending the refractive surgery clinic for LASIK assessment. Refraction and CCT measurement were conducted on 714 patients using the Orbscan II (Bausch and Lomb, Rochester, NY, USA). Their results showed mean CCT of $534.5 \pm 38.1 \mu\text{m}$ and mean of refractive error (in spherical equivalent) of $-5.30 \pm 2.74 \text{ DS}$. However, no correlation was found between CCT and the degree of myopia among the subjects ($r = -0.13$, $p = 0.719$).

The primary aim of this study is to determine the standard value of corneal thickness and investigate the relationship between CCT and corneal curvature with degree of myopia among myopic students in Malaysia. Most studies conducted in Asia reported results of only one sample of myopic population in the country. In this study we wish to compare the relationship between CCT and corneal curvature with level of myopia of two main ethnics in Malaysia that is the Malays and Chinese.

MATERIALS AND METHODS

Subjects consisted of 84 myopic university (51 females, 33 males) students from Malay and Chinese origin. The inclusion criteria include VA of 6/9 (Snellen) or better with correction, non-contact lens wearer and free from ocular and systemic disease. The protocol of this study was approved by Ethical Committee, Hospital Universiti Kebangsaan Malaysia and informed consent was obtained from all subjects.

All measurements were conducted on both eyes at the Optometry Clinic, Faculty of Allied Health Sciences, Universiti Kebangsaan Malaysia. Measurement of refractive status was conducted using subjective refraction with cross cylinder and visual acuity (VA) was taken using Snellen chart at 6m. Measurement of corneal curvature was taken using keratometer (Shin-Nipon, Japan).

MEASUREMENT OF CORNEAL THICKNESS

Corneal thickness was measured at central and peripheral areas using ultrasonic pachometer (Corneo-GageTM Plus 2, Sonogage, Japan). Radial Keratometry mode was used to measure corneal thickness in this study as the result represent the thickness of the whole cornea, without separating the thickness of epithelial, stromal and endothelial layers. Measurement was conducted at five different locations on the cornea that is the central, temporal, nasal, superior and inferior of both eyes. Topical anesthetic (Benoxinate Hydrochloride, 0.4%) was instilled on both eyes prior to measurement.

In order to ensure that the deviation angle of the eye is equal during measurement of peripheral corneal thickness, subject was instructed to fixate at four different fixation targets pasted on the wall during examination. These targets were located at a distance of 310 cm from the subject's eye. The central target was placed at the height of 140 cm from the floor and 4 peripheral targets were pasted at 104 cm above, below, right and left of the central target. The deviation angle of the eye (θ) during fixation on the peripheral target can be calculated as $\tan \theta = 104/310 = 0.3355$, resulting in $\theta = 18.5^\circ$.

Adjustable chair was used to ensure that the central target was always aligned with the visual axis of the subject. Subjects were asked to fixate at the opposite target for peripheral areas measurement. For example for inferior corneal thickness measurement, subject was asked to fixate at the superior target. Three readings were taken from each locations and the mean was calculated. Fifteen readings were obtained from each eye.

The data were analyzed using Student's *t*-test to evaluate the differences in CCT, corneal curvature and refractive error between males and females or Chinese and Malays. One-way ANOVA was used to compare CCT with measurements of 4 different peripheral parts of the cornea. Statistical significance was assumed at $p < 0.05$ level.

RESULTS

A total of 168 eyes from two main races in Malaysia (82 eyes, Malays and 86 eyes, Chinese) were examined in this study. The results of 168 eyes were reported in this study as initial analysis showed poor correlation between right and left eye measurements. The subjects' demographic data are shown in Table 1.

TABLE 1. Demographic feature of subjects

	Malays (<i>n</i> = 41)	Chinese (<i>n</i> = 43)	Total (<i>n</i> = 84)
Sex			
Male	9(22%)	24(56%)	33 (39%)
Female	32(78%)	19(44%)	51(61%)**
Age (Mean \pm SD)	22.46 \pm 0.88	20.34 \pm 1.14	21.42 \pm 1.47
Refractive error (Spherical Equivalent)	-3.13 \pm 1.89 DS	-3.85 \pm 2.24 DS*	-3.50 \pm 2.10 DS
Corneal curvature (Mean \pm DS)	7.60 \pm 0.66 mm	7.87 \pm 0.28 mm*	7.74 \pm 0.52 mm

* $p < 0.05$, significant difference between race (independent sample *t*-test)

** $p < 0.05$, significant difference between gender (independent sample *t*-test)

The mean age for the whole subject population was 21.42 ± 1.47 years old, 22.46 ± 0.88 years old for the Malays and 20.34 ± 1.14 years for the Chinese respectively. Mean refractive error in spherical equivalent was -3.50 ± 2.10 DS, with -3.85 ± 2.24 DS for Chinese and -3.13 ± 1.89 DS for Malays. Statistical analysis revealed no significant difference in the age and refractive error between gender and two racial groups ($p > 0.05$). Distribution of refractive error in spherical equivalent for this study population is shown in Figure 1.

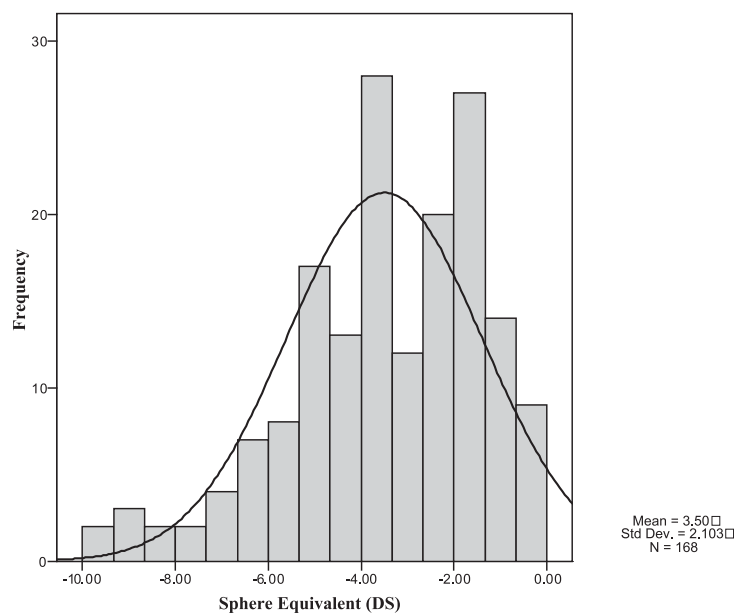


FIGURE 1. Distribution of refractive error in sphere equivalent (DS)

Results from keratometer measurement indicated that the mean of corneal curvature for the all subjects was 7.74 ± 0.52 mm, with 7.87 ± 0.28 mm for Chinese subjects and 7.60 ± 0.66 mm for Malays. Pachometry measurement was conducted at central (CCT) and peripheral areas (PCT) of the cornea. Significant difference ($p < 0.05$) was shown between mean CCT and PCT, where CCT was found to be significantly thinner than PCT for all subjects. The mean CCT found for all subjects was 596.03 ± 45.67 μ m. The mean values of CCT for Chinese subjects were 565.61 ± 34.49 μ m and 625.04 ± 77.73 μ m for Malays.

Mean values of PCT for all subjects and Chinese and Malay subjects respectively were as follows: inferior, 691.84 ± 61.56 μ m, 661.15 ± 44.87 μ m and 724.04 ± 56.12 μ m; superior, 682.30 ± 67.04 μ m, 650.35 ± 43.57 μ m and 715.82 ± 71.09 μ m; nasal, 711.54 ± 51.69 μ m, 710.81 ± 54.26 μ m and 712.31 ± 49.18 μ m and temporal, 675.15 ± 74.29 μ m, 634.51 ± 37.95 μ m and 717.76 ± 58.65 μ m. Chinese

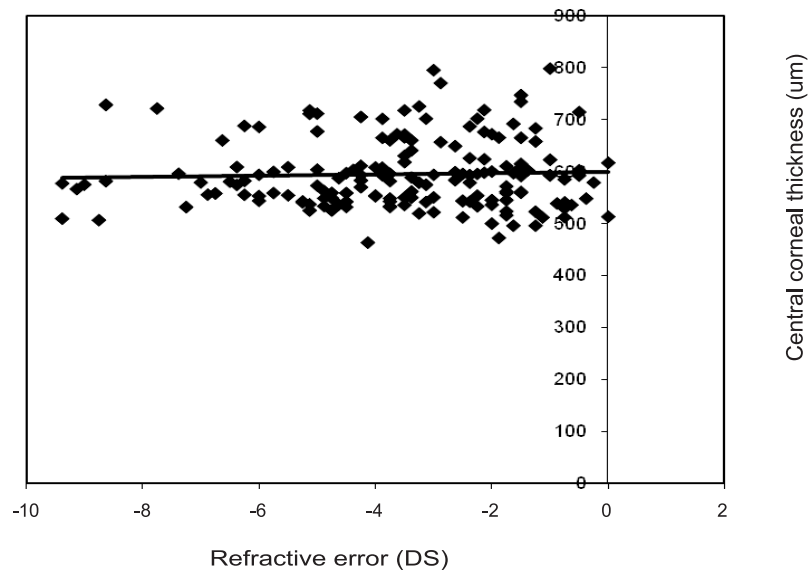


FIGURE 2. Scattering plot showing the association between degree of myopia in spherical equivalent and central corneal thickness (CCT) ($r = 0.125$, $p > 0.05$)

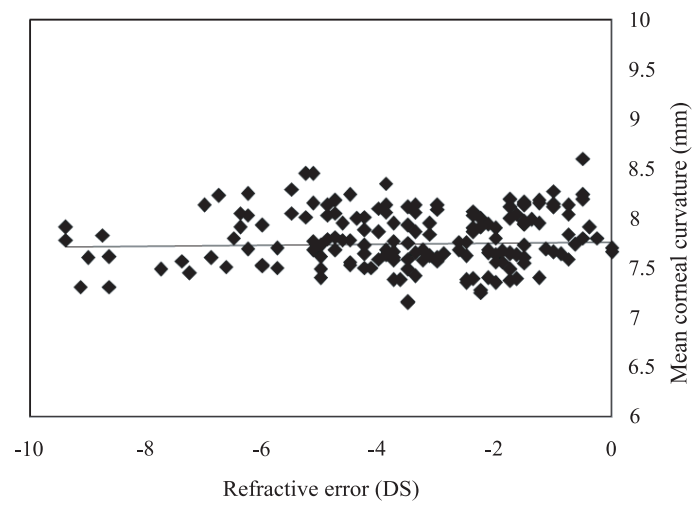


FIGURE 3. Scattering plot showing the association between degree of myopia in spherical equivalent and mean of corneal curvature ($r = 0.246$, $p > 0.05$)

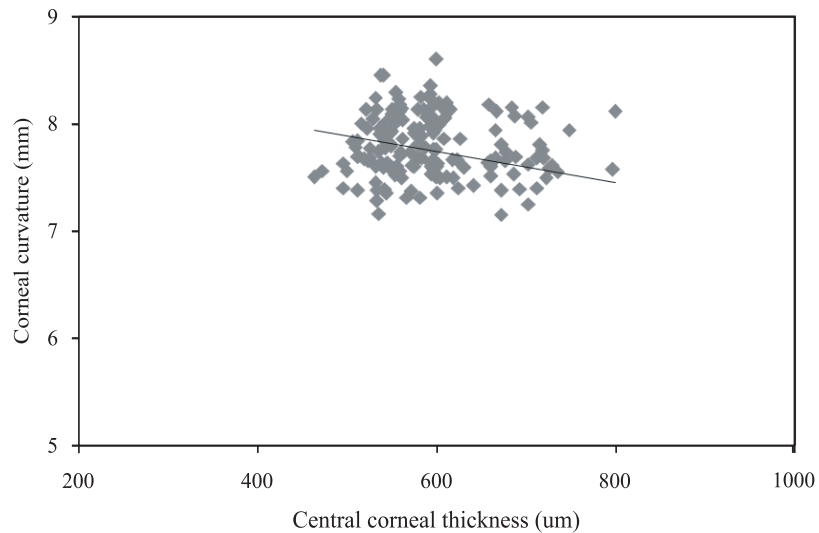


FIGURE 4. Scattering plot showing association between corneal curvature and central corneal thickness (CCT) ($r = 0.184, p > 0.05$)

subjects were shown to have significantly thinner CCT ($p < 0.05$), but thicker superior and temporal parts of the cornea when compared to Malay subjects of similar refractive error.

Significant difference ($p < 0.05$) of mean CCT was also found when the subjects were divided into two groups, following the degree of myopia. High myopic subjects (-4.25 DS and above) were found to have significantly thinner corneas than low myopes (-4.00 DS and below). However, poor correlations were seen between refractive error and CCT ($r = 0.125, p > 0.05$) (Figure 2), refractive error and corneal curvature ($r = 0.246, p > 0.05$) (Figure 3) and corneal curvature and CCT ($r = 0.184, p > 0.05$) (Figure 4) for all the subjects in this study. Results of corneal thickness measurement are summarized in Table 2.

DISCUSSION

This study examines the relationship between CCT and myopia. The mean CCT found for all subjects in this study was $596.03 \pm 45.67 \mu\text{m}$. Results from other Asian countries using similar instrument on young myopic population showed slight variation in measurement. Mean value of CCT found in Hong Kong Chinese was $560.8 \pm 34.4 \mu\text{m}$ (Lam and Douthwaite, 1998) and in Taiwanese was $533.00 \pm 29.00 \mu\text{m}$ (Chang et al. 2001). We understand that it is not ideal to compare the data of this study directly with previous reports. However, it is reasonable to do

TABLE 2. Pachometry measurement (Mean \pm SD) of five different regions on the cornea

	Malays (<i>n</i> = 82)	Chinese (<i>n</i> = 86)	Total (<i>n</i> = 168)	<i>p</i> value
Central (μm)	625.04 \pm 77.73	565.61 \pm 34.49	596.03 \pm 45.67	<i>p</i> = 0.025
Inferior (μm)	661.15 \pm 44.87	724.04 \pm 56.12	691.84 \pm 61.56	<i>p</i> = 0.130
Superior (μm)	650.35 \pm 43.57	715.82 \pm 71.09	682.30 \pm 67.04	<i>p</i> = 0.029
Nasal (μm)	710.81 \pm 54.26	712.31 \pm 49.18	711.54 \pm 51.69	<i>p</i> = 0.477
Temporal (μm)	634.51 \pm 37.95	717.76 \pm 58.65	675.15 \pm 74.29	<i>p</i> = 0.002

**p* < 0.05, significant different using independent sample *t*-test

so as all the measurements were obtained using ultrasonic pachometer. Difference in CCT values measured with different instruments has been previously reported (Thomas et al. 2006; Kim et al. 2008). Specular microscope gives significantly lower CCT values than ultrasonic pachometer (Bovelle et al. 1999).

In this present study, CCT was found to be thinner in high myopes (-4.25 DS and above) than lower ones (-4.00 DS and lower). Similar findings were reported by Tokoro et al. (1976) and Chang et al. (2001). Studies by Liu and Pflugfelder (2000), Price et al. (1999) and Fam et al. (2006) could not find any correlation between CCT and degree of myopia. This could possibly be due to small subject population used in the study.

Our analysis also revealed poor correlation between CCT and corneal curvature with the level of myopia. Radius of corneal curvature was not found to be associated with CCT, as described earlier among Hong Kong Chinese individuals (Cho and Lam 1999). However, the associations have been found in some other studies (Giasson and Forthomme 1992; Shimmyo et al. 2003).

There are few limitations in this study. Due to time constraint, the intra ocular pressure (IOP) was not measured in this study. The prevalent risk of glaucoma is higher in myopes than normal population and CCT may be important in this context (Saw et al. 2005). We also did not use emmetropic sample for comparison. However, we tried to compare our data with a population based study conducted at the same region to justify our findings.

CONCLUSION

It was concluded from this study that high myopic adult has thinner CCT than lower ones. CCT measurement should be considered by practitioners in Malaysia before performing any clinical procedures involving the cornea such as LASIK or Orthokeratology.

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Received: June 2008
Accepted for publication: February 2009